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BULLETIN OF THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION

Vol. V LANCASTER, PA., JANUARY, 1915 No. 5

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BULLETIN

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EDITORIAL.

Advantages of Attendance at Conventions.—The editor feels as though he were calling attention to a family matter when he makes mention of the excellent article by Chancellor McCormick appearing in this number of the BULLETIN. Speaking as a member of the faculty who has served for some time under Chancellor McCormick, and who has seen the growth and success which has attended the University of Pittsburgh

under his direction, he believes that this is due in no small degree to his insistence upon the importance of members of the faculty attending educational and scientific conventions. In this article he speaks freely of the reasons for such attendance and the benefits which may be derived.

The Institutional Delegate.—At the Minneapolis meeting of the Society, the secretary and committee on college administration suggested that a new type of membership be created in the Society to be known as institutional membership. Educational institutions teaching engineering subjects were eligible.

During the first year some forty-eight institutions availed themselves of this opportunity. Many of these institutions sent delegates to the Princeton meeting of the Society. At this meeting two sessions of institutional delegates were held, at which various subjects pertaining to the institutions, as such, were presented. One of the things embodied at this meeting was the necessity for the delegate presenting in the most emphatic way, the actions of the Society, to the heads of the institutions which they represented. This provides a direct method of presenting to the administrators of colleges the latest ideas concerning engineering education. This report also presented to the faculty, ensures that members of the faculty as a whole, shall be familiar with the modern plans of engineering education.

In this number of the BULLETIN we are printing such a report. This report seems to sum up in a clear and comprehensive way the modern tendency in engineering education. The report of Professor Young presented to the University of Toronto, and published in the *Canadian Engineer* is already familiar to many of our members.

COLLEGE NOTES.

Columbia University.—The following men delivered lectures to the graduate students in highway engineering: Mr. A. W. Dean, chief engineer Massachusetts Highway Commission, December 3, on "Specifications for Sizes and Physical Properties of Broken Stone"; Mr. A. W. Dow, chemical and consulting paving engineer, December 6, on "Details of Construction of American Wood Block Pavements"; Mr. S. R. Church, manager research department, Barrett Manufacturing Company, December 7, on "The Essential Physical and Chemical Properties of Creosote Oils for Wood Blocks"; Mr. G. W. Tillson, consulting engineer, December 11, on "European Wood Block Pavements."

Washington University.—The appointment of Mr. James E. Allison, sometime chief engineer of the St. Louis Public Service Commission, as lecturer in economics in Washington University, is of particular interest and importance to the students of engineering in the university. During the second semester of the current year Mr. Allison will deliver a course of lectures under the general direction of the department of economics. The lectures will deal with the economic principles underlying the regulation of public utilities; some of the specific problems to be studied are the organization and operation of public utility corporations, their securities and the methods of financing them, and especially the method of valuing public utility properties for the purposes of taxation and rate regulation. Seniors in the school of engineering, who have for many years been required to take a year's work in general economics, will now be required to take this new course which will replace in part the second semester's work in general economics. It is believed that the establishment of this course presents an unusual opportunity, both because of the importance of the subject and the high standing of the lecturer.

In order to further encourage the study of economics by students of engineering of Washington University, Mr. Allison has established a fund to be known as "The Allison Fund," the annual income of which is to be used either for awarding cash prizes or in such manner as in the opinion of the dean of the school of engineering and the head of the department of economics will best promote the object of the fund. When a prize is offered, competition will be open to the students of engineering who undertake a special investigation of the field of public utilities under the direction of the department of economics, with such restrictions as to eligibility as may be specified from time to time.

University of Minnesota.—Professor W. H. Kavanaugh, head of the experimental department of the college of engineering, has been elected chairman of the Minnesota Section of the American Society of Mechanical Engineers.—Professor Frederick M. Mann, head of the department of architecture of the college of engineering, has just returned from the meeting of the Association of Collegiate Schools of Architecture and also the annual convention of the American Institute of Architects held in Washington, D. C.—The department of architecture inaugurated three years ago in the college of engineering has proved to be well timed. The conditions were favorable in every way because the college of engineering itself was already giving many of the fundamental courses which an architect must take as well as an engineer. The Twin Cities, especially with the new art institute in Minneapolis, form an art center which was incomplete without an adequate school of architecture. At the present time sixty students are registered in the college of engineering in architecture and architectural engineering. Of this number thirty-nine are freshmen, thirteen are sophomores and eight are juniors. In addition forty-two students are registered in the extension courses in architecture given for the most part as night work. The more advanced students in these courses are taking part in the competitions conducted by the Society of

Beaux Arts Architects of New York. During the past year Minnesota students entered these competitions with excellent success, in two cases winning an award of the highest grade. In the last competition, closed about two weeks ago, fifteen sets of drawings were sent in from Minnesota, eight of which received honorable mention.

Yale University.—Since the opening of college in October the following lectures have been given under the auspices of the different engineering organizations of Sheffield Scientific School: Line Construction in the New York, New Haven and Hartford Electrification, by Mr. R. P. Winton; Recent Developments in Large Power Houses, by Mr. Henry G. Stott, Superintendent of Motive Power, Interborough Rapid Transit Co., New York; Electricity in the Navy, by Lieutenant R. S. McDowell, U. S. N.; A Variable Speed Hydraulic Transmission Gear, by Mr. Reynold Janney; The Goldschmidt Process, by Mr. W. R. Hurlbert; Certain Psychological Principles Involved in Teaching, by Professor R. P. Angier; Recent Developments in Radio-Telegraphy, by Mr. John L. Hogan, Jr., Chief Research Engineer of the National Electric Signaling Co.; The Prevention of Accidents in the Iron Mines at Mineville, N Y., by Mr. S. Lefevre.—The fall meeting of the New Haven Branch of the American Society of Mechanical Engineers was held in Mason Laboratory of Mechanical Engineering, the afternoon and evening of November 18. In the afternoon, Professor C. F. Scott read a paper on Electricity in Manufacturing, and in the evening there were addresses by Mr. James Hartness, President, and Mr. Calvin W. Rice, Secretary of the Society, followed by professional papers.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY OPENS AERODYNAMIC LABORATORY.

The opening of the new flying machine study laboratory of the Massachusetts Institute of Technology took the form of a collation at the University Club where Henry A. Morss, '93, was host to the assembled company. Members of the corpora-

FIG. 1.

tion and of the faculty were in attendance with President R. C. Maclaurin as master of ceremonies. For the guests there were Dr. A. F. Zahm, of the Smithsonian Institution, Professor George E. Hale, '90, and Professor Alexander McAdie, di-

rector of Blue Hill Observatory. Professor C. H. Peabody, head of the department of Technology of naval architecture, aided by assistant professors H. A. Everett and H. H. W. Keith were scouts, seeing to it that all the members of the company met the guests. Following the collation the scene of activity was transferred to the new M. I. T. aeronautical laboratory at Cambridge, the first permanent building on the

FIG. 2.

new site, where Lieutenant J. C. Hunsaker, under whose direction the courses are being given, and his assistants actuated and explained the apparatus.

This very simple programme served to dedicate the new laboratory, M. I. T. being the first institution in the country and probably in the world to establish regular courses in the principles underlying aerial flight. In recognition of this the

Smithsonian has sent to represent it Dr. Zahm, who has followed former director S. P. Langley of the Institution in being the head of the experts on the action of the atmosphere and wind, while Professor McAdie as the director of the Blue Hill Observatory represents the most active institution in the world in initiating and carrying forward the study of conditions at those heights to which the aeroplane must rise.

The following telegram was received: "The Aero Club of America sends greetings to the Massachusetts Institute of Technology. We congratulate you upon the inauguration of a real aerodynamic laboratory where experimental and research work may be carried on to the advancement of the art and the science of aviation. It is to be hoped that this laboratory may prove efficient in the elimination of much time, money and effort hitherto unwisely expended. We are sorry that we are unable to send a delegate to represent us at this auspicious occasion, but our felicitations are none the less hearty and sincere and in behalf of the board of governors of the Aero Club of America we wish you in this worthy undertaking a full measure of success." Signed, Alan R. Hawley, president; Howard Huntington, secretary.

In other countries where the actual practise of flying has advanced through dint of much fatal experience to a point far ahead of anything attained here, the necessity is recognized of men who are able to determine the probable safety of flight under existing weather conditions. This factor of flight M. I. T. recognizes the outset, and with Blue Hill so near at hand it has extended to Professor McAdie, through President A. Lawrence Lowell, an invitation to give to the students in aerodynamics special courses in applied meteorology, or in the current terminology, aerology. Such studies will form a part of future courses in aviation.

At the laboratory in Cambridge Lieut. Hunsaker explained the apparatus, which includes a four-foot blowing tunnel in which velocities may reach forty miles an hour. A seven-foot fan sucks the air through the tunnel, in the center of which,

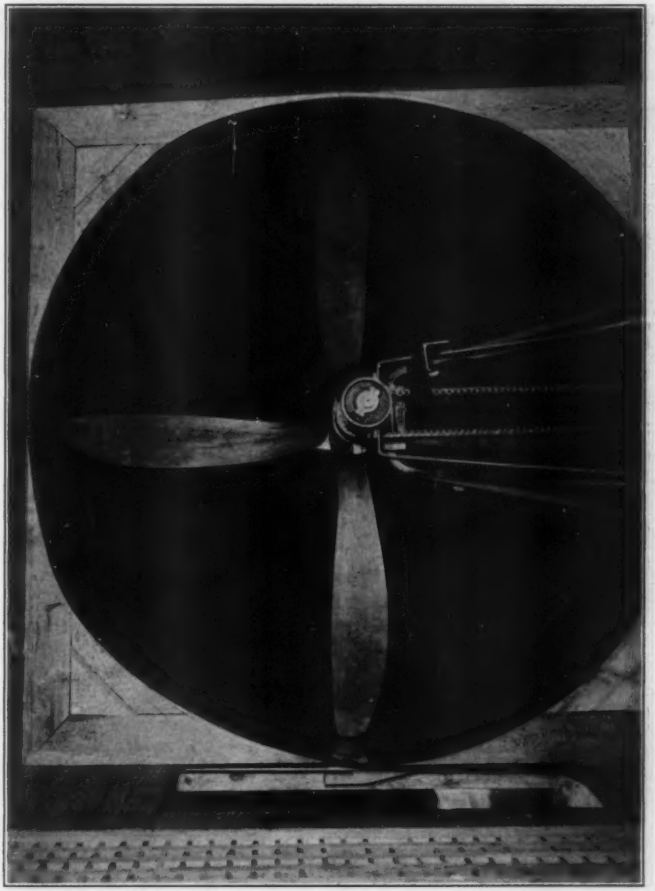

Fig. 3.

where the air currents are most regular and steady, there are arrangements for placing the various devices to be tested. The most novel feature of the equipment is the aerodynamical bal-

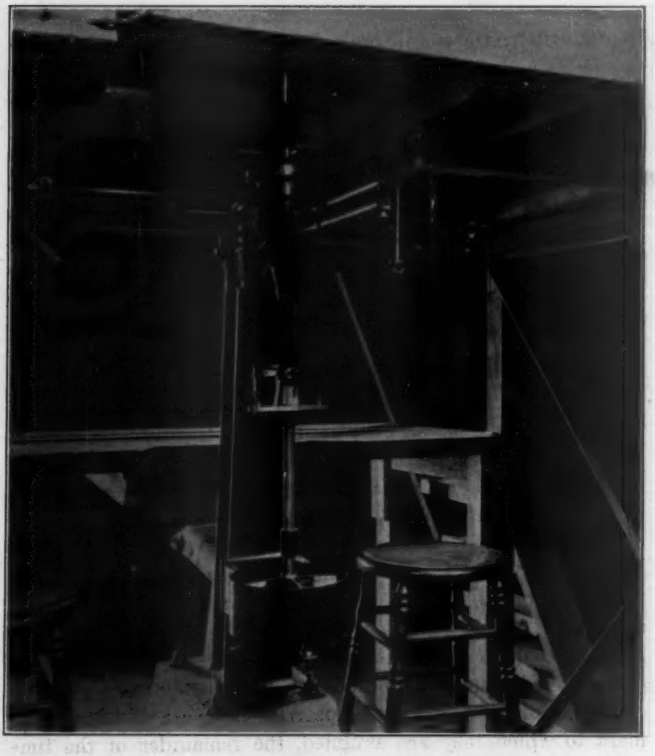

FIG. 4.

ance, an instrument measuring forces in any one of three directions. It measures wind pressure, the twist due to inequalities of pressure and the lift, and is adaptable to all kinds of surfaces. Thus the effect of the wind on planes may be

determined, or on such complex things as propellors or even different forms of sails. The balance is of the pattern of that devised for the National Physical Station at Teddington, England.

It is in a position to get directly at principles, and by doing this it will conserve life and effort, since the rule-of-thumb methods which have prevailed everywhere have often advanced through some accident to the investigators. The courses are in line with the far-seeing policy of Rogers the founder and first president of the Institute, to have men ready for the possible needs of the future. In this new science it is realized that the principles must be mastered and men prepared who can solve the problems in a philosophical way as they arise. Already the government has recognized the value of the new courses and it is proposed by the Signal Service to supply officers for training along the special lines of aerial study.

RESEARCH FELLOWSHIPS.

To extend and strengthen the field of its graduate work in engineering, the University of Illinois has since 1907 maintained ten research fellowships in the engineering experiment station. These fellowships, for each of which there is an annual stipend of $500, are open to graduates of approved American and foreign universities and technical schools. Appointments to these fellowships are made and must be accepted for two consecutive collegiate years, at the expiration of which period, if all requirements have been met, the Master's degree will be granted. Not more than half of the time of the research fellows is required in connection with the work of the department to which they are assigned, the remainder of the time being available for graduate study.

Nominations to fellowships, accompanied by assignments to special departments of the engineering experiment station, are made from applications received by the director of the station each year not later than the first day of February. These nominations are made within the month of February by the station

staff, subject to the approval of the faculty of the graduate school and the president of the university. Appointments are made in March, and they take effect the first day of the following September. Vacancies may be filled by similar nominations and appointments at other times.

Nominations to these fellowships are based upon the character, scholastic attainments, and promise of success in the principal line of study or research to which the candidate proposes to devote himself. Preference is given those applicants who have had some practical engineering experience following their undergraduate work.

BOOK REVIEW.

Engineering Workshop Drawing. By HENRY J. SPOONER, Director and Professor of Mechanical and Civil Engineering, Polytechnic School of Engineering, Regent St., London. The Longmans, Green & Co., London. Pp. 128. Price, $0.50.

As implied by the title, the author takes up the subject with the needs of the shop and of the practical worker constantly in mind, and in so doing makes the book fill a real want. At the same time, in thus presenting the subject, he adds to its usefulness for the technical student. Theory and practice are well handled and advantageously arranged, both in the text and in the numerous well chosen exercises.

C. G. C.

ADVANTAGES OF ATTENDANCE AT EDUCATIONAL AND SCIENTIFIC SOCIETY MEETINGS.

BY S. B. McCORMICK,

Chancellor, University of Pittsburgh.

I am asked to present in a brief form a statement of the advantages gained by members of the teaching faculty of a college or university through attendance at educational and scientific gatherings. I do this with genuine pleasure. I believe in such associations. I am quite confident that without them standards of excellence and enthusiasm for progress would perceptibly decline. In offering a statement of some of the benefits which are derived from personal attendance at these meetings, I do it as one who is thoroughly committed to their real value in the cause of science and education.

I should, however, not like to let slip this opportunity to refer to a situation which needs correction, namely, the unnecessary multiplication of societies, the duplication of organizations in the same territory for the same essential purpose, and the altogether useless congestion of the meetings in the holiday season. So serious has this situation become that it is impossible for an ordinary educator to pay the dues in the societies of which he should become a member; and it is an utter impossibility for him to make satisfactory choice of those which he should like to attend in the Christmas recess —even though he is willing to surrender up the whole of it for the purpose. If a number of the societies should, for instance, merge themselves into the sections of the American Association for the Advancement of Science, a very large part of this problem would be solved.

Inasmuch as the Christmas season is the period when men

should, if possible, be with their families, it is also desirable that state educational meetings and other gatherings of a similar kind should be placed at some other season of the year, in order that no more than a single organization, such as that referred to above, should encroach upon that festival period. Most men surrender very reluctantly any portion of that particular vacation, however valuable they may deem attendance at the association meetings which they esteem most highly.

With this parenthetical suggestion, I present some of the benefits of frequent personal attendance.

The first of these is the formation of friendships. I place this first, because it is probably the most important. Those pursuits which are followed with enthusiasm have always developed friendships among the men of the most varied types and separated in distance far from one another, and work always to the advantage of the individuals and to the enlargement of the sphere of scientific knowledge. To spend the time and money involved in attendance upon an annual meeting, simply to listen to a paper, or even to engage in a discussion, would not ordinarily justify itself with most thoughtful men. Interchange of thought can be carried on by correspondence. The results of research can be made known by publications. Neither of these, if a thousand times more effective than they are today, could possibly accomplish anything comparable with personal contact and familiar acquaintance. It is not simply the feeling of professional solidarity, the exchange of views which increases one's respect for his own profession. It is something deeper and more vital. It is that which comes from personality. It is the arousing of new sympathies. It is the quick awakening of the mind to a new set of ideas. It is the binding of men into a brotherhood. It is the creation of a more adequate background against which to project one's own future work. It is the making of another man out of the jaded person who has, at the cost of money and effort, come to the particular gather-

ing. However wise he may be, his horizon is immensely widened, his life is amazingly enriched, his power of achievement is most effectively enlarged, and the whole man is himself made over into a new creature, for the new and more beautiful world which has through friendships been created for him.

Moreover, the very fact that a man personally knows other men who are engaged in the same profession, absorbed in the solution of the same problems, and working with him in the same field of human endeavor, is a satisfaction beyond the power of words to express. In all the history of civilization, friendships have been formed by correspondence. Many of these have been beautiful and helpful. None of them can possibly equal the real friendship which springs out of actual contact. If scientific gatherings accomplished nothing more than simply to create friendship, they would justify themselves a thousand fold.

The second benefit, closely related to the former, and very largely growing out of it, is the spirit of coöperation which inevitably results from acquaintanceship.

The world is moving forward toward its ultimate destiny. There is a force silently working toward the enlargement of knowledge and the perfecting of civilization. Whatever we call it or however we define it, it is the sum total of the thought and endeavor of men who are working out the problems of mankind, and are giving themselves unselfishly to the service of their fellows. Each man in his place is making some contribution. However effective the aggregate of all the study and thought may be, each part considered by itself, it becomes infinitely more effective when these men touch shoulder to shoulder, and become conscious that they are working side by side with other men, moved by the same impulse and stirred by the same unselfish aim which belongs to themselves. Jealousies are obliterated, and a spirit of harmony and high purpose controls. Individual enthusiasm multiplied becomes an

irresistible power. Discouragements are forgotten. New ambitions are aroused. Coöperation becomes universal.

As an illustration of this thought, we may refer to the present situation, wherein whole nations are engaged in a great conflict of extermination. Whatever other causes have operated to bring about the European war, lack of acquaintance is one which should not be overlooked. If the men responsible could have known each other personally, talked over national problems, so as to gain an insight into the minds of the men of other nations, and thus through personal acquaintanceship and fellowship be able to consider international problems from the standpoint of the wellbeing of people as a whole, it is at least conceivable that instead of conflict and slaughter there would have been harmony and universal advancement. What is true in political and in commercial affairs is true also in education and in science. No one thing is more effective in bringing men together and in inspiring them to largeness of aim and universality of purpose, than gatherings which are attended by men from every part of a nation and from every part of the world.

It becomes increasingly clear that no field of investigation stands by itself, but that the problems are common to all. The individual in a flash is often lifted out of the narrow track along which he has been traveling, to live henceforth upon the wide plain where his energies find untrammeled freedom to accomplish large results. He may discover that he has been traveling in the wrong direction, and that with the contact of mind upon mind, he may turn toward his real goal. Young men especially are oftentimes lifted up out of the bondage of a single man or a single book wherein they have been held captive, and come into the freedom of self-discovery.

A third benefit springs out of the opportunity for full and frank discussion of particular problems. No man, sitting at his desk or engaged in the classroom, is ordinarily able to compass a problem in its entirety, or to foresee all of the relations of the subject which engages his chief interest. Wise legis-

lation, for instance, is possible only in a body large enough to present every view of a proposed law, and small enough to come to a decision upon it. Ideas which had eluded him altogether are presented to his mind. Even a vital thing, lying right at his hand, may have been overlooked, and in the discussion is brought to him and becomes a part of his mental equipment. New discoveries, and practical applications of familiar facts, are often called to his attention, which otherwise might have been unknown for a long time. Professor Huxley once said that "a book in press is already out of date." The man discovers that however alert and progressive he may have thought himself, other men excel him in something. He is able to measure himself, and always, if he is wise, to his own benefit. Younger men discover that writers of books are like themselves, and that they, too, may learn how to write books which may be of benefit to the world. Facts of a purely scientific kind, as he thought, become in the wide range of discussion, facts pregnant with practical and useful applications. Even informal conversations with one's fellows sometimes bring illumination and inspiration. Many a man has dated the beginning of his independent thinking and his enlargement as a force in his institution from his attendance upon some convention or association.

Every person who expects to receive will also purpose to give. He goes not alone for personal benefit, but for the benefit of his fellows. He plans to advance the interests of his own institution and to increase its usefulness to the community. He learns his limitations, and becomes conscious of his own capabilities. Inevitably, a man who keeps in his own place, making no incursion into the world outside, tends constantly to narrow both his sympathies and his capacities. Faculties are unable to legislate wisely in their own institution if they are unfamiliar with what the men in other faculties are doing. He takes the name of his university with him, and spreads its fame; he brings back the spirit of other universities, and enlarges his own. It may not be too much to

say that the ultimate test of professional interest and efficiency is measured by the interest the individual feels in the work everywhere, and his willingness in attendance upon association meetings, both to give and to receive in order to accomplish more effectively the work to which he has given himself.

In thus giving the fullest approval to educational and scientific conventions, it is scarcely necessary to say that it is also possible to fritter away one's time by giving himself too frequently to such expenditure of his time and energy. No individual should attempt to keep himself in touch with too many organizations in his own department of activity, nor to reach out very far beyond his own particular interest. Concentration is as essential to achievement as is breadth of knowledge and wideness of sympathy. Every man must govern himself wisely and have in mind only the strengthening of himself, that his service may be more effective.

PARALLELOGRAMS OF ENGINEERING EDUCATION.

BY J. C. RALSTON,

Consulting Engineer, Spokane, Washington.

The genius who will some day depict the destiny of the engineering profession must perforce recognize two basal divisions. One of these divisions is the in-door science,—the lithology of engineering; the other is the out-door science,—the petrology of engineering. The essence of both is the genius of the profession.

It must be assumed that the matriculating student presents himself to the engineering college with more than a high school education, or in any event, that he has a good grounding in mathematics, having completed at least algebra, plane and solid geometry, trigonometry, the first course in physics covering the entire subject and laying a foundation of general principles for more advanced courses, two years or more in one foreign language, the same time in economics, civics and government, also some knowledge in psychology, philosophy and logic. Further, he must or should be an advanced student in English, with some natural or cultivated facility and felicity in speech and composition. If he has not, he must either make up such deficiency during his college life, or suffer a distinct handicap throughout his professional career. The fact is the engineer has much greater use for a wide, responsive knowledge of his native tongue, than has the surgeon. The latter is seldom required to translate his practice into definite technical statements, while the engineer is continually called on to formulate reports and conclusions in such forceful, precise and illuminating language that the very mind of the writer shall be mirrored in the brief. The lawyer is not required to tell in a formal way how he proposes winning his case; nor must the surgeon outline in detail the manner of the proposed operation or other professional service. The engineer on the other hand

must always present in an orderly, clear and concise way the manner in which he expects to do his work, with a description as well of all the materials to be used. He, therefore, has more use for a command of rich, full explicit English than has the lawyer. Nay more, for the lawyer, at best deals only in matters of opinion and judgment, while the engineer thinks, speaks, writes and works from known and certain premises to inevitable conclusions. He must temper his remarks with such a refined choice of synonyms, and phrase his thoughts in such perfection of clearness, that a master of rhetoric could do no better. He has at his command such a wealth of information that he should be able to dress the same in the glass of fashion and the mould of form,—convincing, irresistible, final, with the finished periods of a Macauley. "An acre in Middlesex is worth a principality in Utopia." It is desirable to know both the grammatical and rhetorical classification of sentences so well that sub-consciously one will intersperse the different forms through an extended text in a pleasing arrangement. "Worth makes the man, the want of it the fellow." Quintilian's rule should be printed on the cuff of every student, namely, "care should be taken not that the hearer may understand, but that he must understand, whether he will or not." Hence the essence of clearness, unity, strength and harmony is as vital as a knowledge of stresses, statics, levers, and hydraulics; if the engineer expects to be more than a technological automaton.

Since the engineer always strives for accuracy in mathematics, so, also, should he strive for precision in language. The other graces of speech and composition may come with experience, but without precision, sloppiness intervenes, and sooner or later it will stamp the bearer with the imprint of failure. If precision of statement is lacking, the public will usually conclude that the same quality is also lacking in technical work.

A persistent and extended reading of the best engineering journals, bulletins, and transactions serves the two-fold purpose of keeping the student abreast of current thought and of

presenting examples of good engineering diction. Many books on engineering minister to the same excellent purposes.

The art of pleasing and forceful address is the outward expression of inward orderliness. Without it an engineer is placed at a great disadvantage; for he can neither secure the recognition which his attainments properly justify, nor can he make his personality or ability commensurately felt. Oral reports and pleadings must often be made to boards and civic and other bodies. A cause must sometimes be pleaded before the public. A few engineers fumble and are inconclusive, if not positively irritating, even on unimportant and self-evident subjects. The majority, happily, are orderly, exhaustive and conclusive enough. Not so many, however, are, in addition, pleasing, forceful, finished and convincing. Testimony before courts and commissions can be made doubly effective by speaking ability. Thus it is possible to command higher fees. "Speech is the instrument by which the fool is distinguished from the philosopher."

Debating and practice in public speaking it would seem are important college necessities.

So much then for some of the footing courses on which our organic structures are to be reared. Let us even more briefly touch, as we see them, one or two essentials in mathematics.

If discontinuous functions are used only as an understanding to the conception of mathematics, those studies which are strictly cognate to engineering must be the ones imperatively demanded in the best mathematical curriculae. Mathematical physics going into every branch of engineering, and running parallel with calculus and analytical mechanics are coördinated into the best results. Certainly a cultivated liking for descriptive and analytical geometry forms a gentle incline towards graphical calculus.

Engineering physics assumes the reality of the outer world and an emphatic realism in mental activity. In this and kindred subjects, the more the text-book relieves the student of taking notes, and the more it supplants the lecturer, the easier is the student led into the fields of permanent mental accom-

plishment. At least it may be said that in taking lecture notes there is a large amount of divided attention, and an equal loss of time. Complaints are sometimes made that the ever-growing output of new books on mathematics and theoretical mechanics has reached the nth power, and that many are written on the basis of "How to Become a Motorman." Luckily, some of the older masters have not as yet been seriously dislodged. On the other hand, however, it is worthy of note that such works as have been written as monographs, are to be commended to the advanced student.

It is altogether evident that extensive recitation work has certainly one immensely commendable feature, and that is that it helps the student to think on his feet, and to enlarge his grasp on the subject into a more definite, crystalline form than when making the study in still life. When the young engineer gets into practice, he will surely find that he will often have to think on his feet, and to think hard and fast. Thus the practice in recitation becomes a substantial asset of practical everyday value; for it is one of the methods by which he translates his attainments into dollars and cents.

Reading current engineering literature in lieu of certain applied work is to be strongly endorsed. I have heretofore suggested that it serves a two-fold purpose. It does more than that. It helps the student to get a better relative idea of himself and his work.

Behind any variation of methods lies the overshadowing necessity of specializing, so far as technology alone is concerned, on those studies which are strictly cognate to engineering, and which make not so much for the conception as for the physical application of mathematics,—the practical application with a physical meaning. Too much abstract mathematics is like sterilized water—it is all pure enough, but it lacks the germ of satisfaction.

While no doubt the tendency in colleges and the demand outside thereof is strongly towards specialization, aside from executive engineering, the fact is that the most intelligent, lasting and agreeable segregation is seldom made by the student

until he has been out of school for some time. The process is one of both mental and physical elimination, rejecting those departments which he knows through investigation and hearsay. In this usually, he is influenced by consideration of location and the prizes of financial regard.

Office work requires certain fundamentals. In all things accuracy first. When one has acquired the habit of accuracy, which is quality, one then may begin to acquire speed, which is quantity. Methodical work and a digested program for every day's work is a promise of efficiency and a guarantee of promotion.

Engineering is the only profession that uses two languages at the same time,—the language of speech and the language of drawing. Whatever is lacking in copper-plate qualities can be made up in legibility. A moment's thought before beginning a drawing will enable the draftsman to place each detail and each printed word, as well as the title, so correctly that when the sheet is finished it will have a completeness of appearance and an element of composition marking it as the product of a skilled workman.

Organization, squad-work and administration in a large office are functions of experience and resourcefulness, although observations on college methods of administration might conceivably suggest something of a foundation.

In a previous paper* I have pointed out that the engineer must of necessity have a primary interest in the political development of the state, and that national ideals with the three divisions of social ideals, artistic ideals and industrial ideals embrace the most constructive application of the technology of engineering, both in the academic and practical sense. Indeed it is proper that the engineer, in the discharge of his citizenship duties, as well as those belonging to himself as an engineer, and to the profession as a whole, should and must occupy a conspicuous position in political thought. The industrial and commercial evolution of the past fifteen years will

* "Parallelograms of Engineering Culture," Vol. IV, No. 2, p. 28, BULLETIN S. P. E. E.

force him to exercise as great or a greater, directing influence in national thought than the lawyer, and perhaps next only to that of the statesman. Within the period just named the stupendous commercial expansion and its concomitant re-alignment, followed, as it naturally has been, with some abuses, must force the trained mind of the engineer to grapple with and direct public thought into rational and final solutions.

Your attention is invited to another coëxtensive subject. I mean the regulation of big business, and little business as well which seems to be a fixed national policy. "We have the spectacle," as Mr. Onward Bates, past president of the American Society of Civil Engineers, pithily observes, "of men without business experience directing in detail how business shall be conducted, holding over the heads of the citizens engaged in business the threat that the government itself will take the business out of the hands of its owners and conduct it as a government monopoly." Here again the engineer is profoundly concerned, for this matter relates to the question of engineering, valuations and to the possibility of engineering itself being engulfed by a Fabian bureaucracy. Mr. Bates adds, "at this point we meet . . . two parties disputing over values, of which one party, with the prestige of government authority behind it, is clothed with the power to do justice, while the other is helpless." And he concludes, "justice depends on the fairness of the party to the controversy which holds the power of decision, and equity can only be secured by having the valuer fair and just and competent."

Again the valuation of Public Utilities for rate-making and other purposes is engaging the best thought of some of the profession, and is, in a sense, opening the eyes of many to the necessity of wide, expansive intelligence on the part of the engineer. A knowledge of the principles of economic laws, like logic, is imperative in this enlarged field. This is peculiarly true in an applied sense, because the engineer must pass by sound methods from the abstract to the concrete. The principles of these larger problems must be correctly established, and the reasoning be so irresistibly rational that where-

as in the past the courts of law were conclusively and sometimes slavishly influenced by the rules of precedent, they must now, in findings on economic questions, be guided more broadly by the principles laid down by the engineer. And the engineers, in modesty, and without disrespect, must refuse to mold their opinions in harmony with legal precedents, just because they are legal precedents, especially so since many of such citations will not stand the acid test of applied economic principles. The courts live in the past; the engineer lives in the present. Reverence for the judicial traditions must give way to the rules of reason.

Allow me also to emphasize a fundamental legal principle concerning railroad property. Railroad property, although having its corporate being by virtue of a franchise from the public, and although devoted to the public service, is not a public property. Nor is it an agent of the state. It is private property, and as such is as much under the protection of the Constitution of the United States, which provides that no person shall be deprived of his property except by due process of law, as is any other form of private property, such for instance, as our banks, our insurance, telegraph, telephone, lighting and power, trust, and steamship companies, or as our mines, hospitals, eleemosynary and educational institutions.

It is, therefore, paramount that all students get a proper concept of such questions at the beginning, and that they thereafter hold tenaciously to the fundamental principles upon which property rights are so wisely founded.

Inasmuch as engineering design translates itself through the instrumentality of the laborer and the mechanic, I have always thought that too little attention is paid to questions of the study of labor. I have stated elsewhere that perhaps sixty per cent. of engineering consists of labor, and forty per cent. of technology. Why should one hundred per cent. of the student's time be given to a study of the forty per cent. division? Possibly that is the reason why engineers are sometimes thought to be impracticable as the directing agents in the handling of large masses of labor. The general who conducts

his campaign successfully is the one who not only is the strategist, but as the commanding chief, inspiring confidence, respect, loyalty and sacrifice in the rank and file of his army, is the recipient of the highest honors which his fellow man can bestow. Why then, in civil life, should not the engineer be the strategist and the field marshall as well, and his corps the war college? It is true that many of the large corporations are recognizing the soundness of this principle; but I sometimes wonder whether the colleges are fully alive to these obvious considerations.

I may be wrong, but it is my present belief that some small definite period should be allotted to the study of labor management,—the sixty per cent. element. Might not the faculties be willing to call in engineers, contractors and other employers to explain how they recruit, organize, grade and manage their labor forces. Steam, interurban and city railroad managers, water works construction, maintenance and repair superintendents, labor agents, and many others are at hand. The driving intensity and the inelastic study hours could, I am sure, be profitably relaxed and interspersed with such outside contact,—the ultra-practical outdoor world. I believe that a small tuition fee would gladly be given by every earnest student to finance such a departure, if no other way could be found. The outside world is just as busy in its pursuits as the college is in its work, and none but the educational enthusiast will be found willing to prepare and give well-digested talks, unless the out-of-pocket expenses at least are met.

Furthermore, it would not be long before sufficient notes would be secured from such talks, so that a reasonably fair course would be worked out. Squad-boss, campus-foreman and summer-school reorganization, having this instruction and experience in mind, could thereby be amplified into encouraging proportions, adding a desirable quality of zeal for all and recognition by credits to the workers.

The qualities of the most accomplished engineer may be likened to a parallelogram. One of the long sides consists of theory; its opposite parallel side embraces practice. The

shorter side, on one parallel, involves culture, and the other, the humanics. Unless the closing end lines are included there would remain only two parallel lines beginning and ending nowhere. Unless the young graduate appreciates the necessity of the completed figure, he is likely, when he receives his diploma, to typify Ochiltree's conception of the person who is filled with a tropical exuberance of promise and a polar sterility of performance.

If an engineer can build a better railway, write a better sanitary code, or make a better kite than his brother, though he live in a tent on the mountain side, posterity, in its verdict of approval, will place him among the few great figures of human periods. This is the reward of the profession.

If engineering transmutes its collective genius into the monoliths of history, or the highways of continental conquest, or into the useful conversion of Nature's latent energies, though it dwell among the humble, it will be given a seat among the mighty. This is the inspiration of the profession. "For," as Emerson says, and as I have paraphrased, "If a man can write a better book, preach a better sermon, or build a better mouse trap than his neighbor, though he dwell in the wilderness, the world will make a beaten path to his door." This is both the inspiration and the reward of the profession.

A CONCEPTION OF ACCELERATION.

BY FRED B. SEELY,

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Few quantities in technical or engineering mechanics give more trouble in teaching or seem more elusive to engineers than acceleration.

The engineer is interested in acceleration chiefly as a means to an end. The inertia forces developed are usually of prime importance. Thus the acceleration through its relation to the forces acting and the stresses developed holds the key to most kinetic problems.

On the other hand, acceleration itself is usually treated merely as a property of the geometry of motion, devoid of any physical meaning because the observation and experience of the student are not drawn upon in defining or interpreting it.

After several years experience in teaching advanced kinetics to mechanical engineering students who had already completed the elementary course in analytical mechanics, it is the opinion of the writer that much difficulty encountered in this field by the average student is traceable to the lack of a clear physical conception of acceleration and, perhaps to a lesser extent, of all vector quantities.

In order to understand the student's conception of acceleration it will be well to recall some of the difficulties which arise. Perhaps the simplest case and the one in which trouble first reveals itself is in connection with the normal acceleration of a point moving in a curved path ($a_n = v^2/\rho = \omega^2\rho = v\omega$). The difficulty as a rule asserts itself by reasoning on the part of the student somewhat as follows: The acceleration, in any direction, of a moving point is defined as the rate of change of the velocity in the given direction; in the case of a point moving in a curved path (circle say), how can there be

an acceleration toward the center when there is no velocity toward the center?

In fact it has been stated that normal acceleration is a "mathematical fiction," that is, it has no physical basis or meaning or in other words the definition of acceleration does not appeal to observation and experience for its meaning.

To add further evidence of similar difficulty it would be necessary only to quote statements made by students to the effect that component accelerations (especially in the more complex cases) occur where according to the definition they have no right to be present; or, that acceleration seems too often only a mathematical expression devoid of physical meaning.

In order to determine a little more definitely the idea of acceleration in the minds of students of the junior class who had completed the study of kinematics through curvilinear motion, the following questions were asked at the first recitation of the fall semester. The fact that the summer vacation had intervened tended to leave only the fundamental conceptions which had crystallized in their minds when studying the subject.

1. Define acceleration at any instant of a point moving in any curve (a) in the form of a word statement, (b) in the form of an equation.

2. Does the direction of the velocity of the moving point have any influence in determining the acceleration? Explain.

3. The acceleration at any instant of a point moving in a curve (say a circle) is defined as the time rate of change of the velocity at the instant. The velocity at any instant is tangent to the path. Can there be any acceleration toward the center? Explain fully.

Fifty men answered questions 1 and 2 only and thirty other men answered question 3 only. Twenty-three of the fifty answered 1(a) correctly and gave $a = dv/dt$ for 1(b). The answer for 2 in these twenty-three cases was that the direction of the velocity determined whether the acceleration was posi-

tive or negative. Three men answered 1(*a*) and 1(*b*) the same as above and answered 2 "yes" because a force is required acting toward the center, etc., etc. Three men answered 1(*a*) and 1(*b*) the same as above but answered 2 "no" because acceleration was defined as dv/dt which was not influenced by the direction of v. Eleven men answered 1(*a*) and 1(*b*) the same as the twenty-three above and answered 2 "yes" because velocity was a vector quantity, five of the eleven adding that the direction of the velocity changed toward the center, hence there must be an acceleration, etc. Three gave the equation $a=\sqrt{a_t^2+a_n^2}$ for 1(*b*) but answered 2 the same as the twenty-three above.

Of the thirty who were asked question 3, eighteen answered "no" because there could be no rate of change of velocity toward the center when there was no velocity toward the center. The other twelve answered "yes" because velocity was a vector quantity. Six of the twelve gave a satisfactory explanation by showing that the direction of the velocity changed toward the center.

Without discussing the limitations or difficulties connected with such a method of obtaining the information desired let it be said that the papers were examined in a liberal spirit, an attempt being made to read the ideas behind the statements.

It is clear from the nature of the difficulties illustrated above and from the answers to the above questions that to the majority of the students the definition of acceleration means simply rate of change of the *magnitude* of the velocity (speed). In other words, the statement that velocity and acceleration are vector quantities does not make a sufficiently strong appeal to most students. Such a statement does not bring to mind any physical laws. Normal acceleration was thought of as an *additional* acceleration not included in or covered by the definition. This fact was also made clear in the discussion which followed the answering of the questions.

All of these men had, when studying the subject, given a

derivation for the normal acceleration ($a_n = v^2/\rho$) and no doubt they could have done so again if time had been allowed for review, yet very few were able to explain even in a rough way why such an acceleration should exist at all according to the definition.

It may be urged that the conception of force through its relation to acceleration ($F_n = ma_n$) furnishes all that is necessary for recognizing the existence of acceleration. In the simple case of normal acceleration this is a natural and proper check, although it adds little meaning to acceleration itself. But in most problems in kinetics we are led to the forces in various directions by means of the component accelerations in those directions after which the forces are combined in such ways as to appeal more directly to our experience or to interpret their effect in the simplest or most effective manner. It is important, therefore, that acceleration itself entirely disconnected from the conception of force should have a physical basis and interpretation involved in its definition.

This tends to draw a sharp line of distinction between equations which express physical or experimental laws and equations which are steps in the analysis of such laws. It also helps to render unnecessary the building of special machinery for interpreting results or for attacking new problems. It helps to develop a natural, logical and powerful method for handling kinetic problems.

After a certain point in an analysis is reached an attempt to give a physical interpretation may be quite undesirable; this, however, does not make it any the less important to fully appreciate the physical nature or properties of the quantities involved.

To have the definition of acceleration complete and at the same time based on physical facts requires the introduction of Newton's first and second laws of motion, perhaps not in the language usually employed to state these laws but to the effect that observation and experiment show that when a particle is given a motion in a definite direction and with a definite speed

it stubbornly tends to hold both the direction and speed. Or, the same kind of a physical agent, namely a force, is required to produce a change in each property of the motion. Hence velocity has two *inherent* properties, magnitude (called speed or swiftness) and direction. Therefore acceleration—the rate of change of velocity—may be due to change in either one of these inherent properties since they are independent properties or a change in both occurring simultaneously. Furthermore, the change in direction of the velocity must take place in a definite direction at any instant as well as the change in magnitude, both of which directions appeal directly to observation and experiment.

Mathematics here comes in not to interpret but simply to give the exact magnitudes of the rates of change of these two properties which are directly connected with physical laws and which rest upon such laws for their existence and full meaning.

In short, to state that velocity is a vector quantity should bring to mind the same physical conception as Newton's first law does and to state that acceleration is a vector quantity should call to mind part of the same physical conception as is involved in Newton's second law.

Since velocity has only these two inherent properties and acceleration can arise *only* when a change occurs in either of them, the fact that it is sometimes more convenient to make use of x and y components or radial and transverse components; or to explain that the velocity in a given direction at any instant may be zero although it may be changing either in magnitude or direction in the given direction, does not lessen the importance of the method of approach discussed above. And in most cases arising in engineering kinetics normal and tangential components to which the definition directly leads will be of most importance. Thus after understanding why accelerations exist in definite directions and after mathematics has shown that when a velocity changes direction the rate at which it changes direction is v^2/ρ or u^2/r or w^2/R, etc. (where

v, u or w is the magnitude of the velocity or component velocity which is changing direction and ρ, r or R is the radius of curvature of the path to which the velocity v, u or w respectively is tangent), and after the fact is appreciated that dv/dt, du/dt, dw/dt gives only the rate of change of the *magnitude* of the velocity, the derivations and applications of the more complicated acceleration equations for relative motion, such as Coriolo's law, may be approached with confidence.

An examination of some of the American text-books known to be in use in various universities and technical schools was made with the purpose of determining what equipment a student would have after studying the dynamics as presented in these texts. In the writer's opinion the texts leave much to be desired in connection with the vector quantities involved, such as linear and angular displacement, velocity, acceleration, momentum, and especially linear acceleration which is of vital importance in the method of attack usually employed for kinetic problems.

Engineers are continually demanding more of mechanics to meet the increasing number of kinetic problems. More refined analyses are required to accompany higher speeds, better material and more exact knowledge of the strength of materials. In view of these facts a change in attitude toward the teaching of mechanics, especially of dynamics, is becoming necessary. Those who have felt the need for some readjustment and have found relief through some tried method would render real service by presenting it for the benefit of others in the same field.

REPORT OF AN INSTITUTIONAL DELEGATE TO THE ANNUAL CONVENTION OF THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION AT PRINCETON, JUNE 22–26, 1914.

By S. L. CONNER,

Assistant Professor of Railroad Engineering.

To the Acting President of Tufts College:

As institutional delegate from Tufts Engineering School to the annual convention of the Society for the Promotion of Engineering Education held at Princeton during the month of June, I desire respectfully to submit for your consideration some of the important facts and recommendations which were brought to my attention through the papers submitted and the resulting discussions, and from informal conversations with many of the members present.

Throughout the whole of the meeting there seemed to be a spirit of unrest and of general dissatisfaction with the condition of the field of engineering education. Attention was called to the position of the engineer in the affairs of the world, his apparent disinterestedness in the problems of civic life, and his lack of ability through lack of training to take a prominent place in business affairs.

That this is deemed a serious condition is evidenced by the findings and the testimony of many of our prominent educators. Dean Benjamin of Purdue University has examined the history of 3,500 graduates of the engineering school, particularly with respect to their fitness for professional work. His investigations show that the graduate had little knowledge of commerce, of business methods and economics, and in order for him to secure further knowledge of affairs he must devote himself to their study for several years after gradu-

ation. Dean Benjamin also found that the literary side of the graduate's education had been too much neglected and that he is frequently unable to express himself properly either in writing or speaking. An experiment to meet this condition is being made at the new school of technology which is a part of Johns Hopkins University, and Professor Whitehead of the Department of Engineering, as a result of his investigations, has made the following statement: "The average engineering graduate is wanting in general education, in powers of expression, in imagination and ability to reason." In consultation with employers, engineers and educators, Professor Whitehead has found that these imperfections are generally recognised and freely criticised. He also adds that "complaints of too great insistence on professional training, to the sacrifice of fundamentals and cultural studies, were particularly widespread."

Many suggestions were offered to meet this situation, and in presenting some of them for your consideration I am fully convinced that, if they are actual weaknesses and so evident to those outside of our profession as well as to the leaders in our engineering thought, then special efforts should be made in endeavoring to analyze the reason for their existence, and also in attempting to afford some definite relief.

I gleaned from the discussions of the papers and in conversation with many of the members that these improvements are to come from several sources and, that although there are numerous factors affecting the solution of the problem, yet it was considered possible to reduce these to a minimum. I will mention several of these factors that were deemed important, viz.: the mental calibre of the men whom we have to train, the sources from which they are secured, their home influences and their natural tendencies; and for our particular consideration, since we are interested in the methods to produce the result, the courses that are given, methods of teaching, the teacher, and administration.

Courses.—In framing new engineering courses, or in the improvement of existing ones it was felt that the ruling thought

should be to see that whatever is taught is closely related to the entrance requirements of the college, to the probable character of the future employment of its graduates and to the personal qualities desirable in an engineer.

In considering the correlation of the entrance requirements and the probable development to follow in the courses to be subsequently taught the student there appeared several factors to be borne in mind, viz.: in order to meet the needs of the community the technical college must carefully and continuously study the shifting field of employment of engineers and train its students accordingly; if the course is made of given length then the general equipment and scholarship of the graduates will be largely determined by the conditions of entrance; the need for considering the wants of the average man rather than the exceptional one, since by all the rules of probability we deal mainly with men of average calibre.

Not only must the broad departments of engineering likely to absorb graduates be considered, but the probable range of their future employment as graduates should receive attention. Instances are familiar to all of us where engineering graduates of one department find their life work in another department, and as a matter of prudence the student should be equipped for the transfer. It was pointed out that there is a tendency to join business to technical training by reason of the increasing number of positions demanding of their incumbents both technical and business training. Professor Scott has stated that one-half of the members of the three principal engineering societies of the country are in executive positions. Comparatively few are, or will be, engaged at wholly technical pursuits and of these only a minority will be so occupied for any length of time. In all probability a large number of graduates of engineering colleges will in the future be called upon to assume duties of a mixed technical and executive character.

For business and professional reasons alone, and quite apart from higher motives, engineering education should aim to develop in the student, strength of character, reliability,

industry, intellectual capacity, well ordered knowledge of his own field, knowledge of men, address and popularity. For the majority of positions that engineers are called upon to fill the last three mentioned, knowledge of men, address and popularity are of the utmost consequence.

The curriculum for the engineering student should then, it was felt, include three classes of subjects; those involving the technical side of engineering, economic subjects, and cultural subjects. In providing courses in technical subjects based on physical, chemical and mathematical science, care should be taken to select such subjects as give to the student that introduction to professional practice required in order that he may become an engineer. In making the final selection of courses there should be such coordination of thought and development, that these courses should correspond to the probable range of future employment of the average graduate and at the same time enable the undergraduate actually to put this knowledge into profitable use at any period of his career as a student, particularly during his vacation holidays. It was also recommended that the problems that 70 per cent. or 80 per cent. of the graduates of an institution will be called upon to solve should influence, if not actually determine, the subjects to be taught, rather than those with which 20 to 30 percent. may occasionally be confronted.

In selecting courses for economic subjects there should be provided those that reveal to the student economic laws and business methods, organization, management, business finance, commercial law and accounting, and business procedure. There is here, however, the same difficulty as would be apparent in the presentation of technical subjects, namely the tendency to encumber the student with numberless details.

By those who have given considerable study to this question, cultural subjects are now generally regarded as not only a desirable but a necessary part of an engineering course. Already many institutions have given a place to cultural subjects in outlining their courses, and there have been included

such subjects as psychology, philosophy, logic, ethics, political science and oratory.

Methods of Teaching.—Considerable argument was developed on this line of thought and it was pointed out in a paper presented by Professor McDaniel, of the University of Illinois, that it was of especial importance to correlate theoretical subjects with practical engineering problems if the interest of engineering students was to be maintained. Quoting Professor McDaniel's speech in part: "Generally, the speaker has found the student equipped with a vague idea of the trigonometric functions. Beyond the fact that they are certain abstract forms, they mean very little to him. He does not readily see their significance in the solution of problems on paper, and in the field. The reason for this is clear. The subject is taught in an abstract way and not in correlation with the dependent branches of engineering. Some schools, notably the College of Engineering at the University of Minnesota, have endeavored to solve the problem by employing teachers with engineering training for the courses in mathematics. This method has proved to be quite satisfactory and efficient."

While it is necessary to vivify the subject, and present it in a concrete manner, with the thought in mind that the principles as taught have a future application, yet in order indelibly to fix fundamentals on the student's mind it is absolutely necessary to confine the teaching largely to fundamentals.

Professor D. C. Jackson, of Massachusetts Institute of Technology, spoke very strongly on this phase of the subject and as follows: "I am strongly in favor of emphasizing the instruction in mathematics, but particularly in calculus, on the side of the interpretation of the meaning of equations into simple terms of English, as the terms of English are those in which one ordinary thinks, and it is necessary to make such interpretation in order that the logical processes of mathematics may be incorporated within ordinary processes of thought and analysis."

One of the important points of this phase of the methods of teaching was indicated in the paper "Teaching Engineers

to Study," as presented by Professor Geo. L. Sullivan. He recognizes that the student must rely wholly upon himself when his college days are over, and that the teacher of skilful judgment will seek to provide the student with adequate means of self-help. Primarily the engineer as a student or as a practising engineer after graduation must know how to study, but usually he does not. At Brown University an experiment is being made to encourage the student, by special recognition, to devise improved methods of study of the various subjects of the curriculum. As successful engineering is largely dependent upon skilful decision, and upon good judgment, a special effort should be made to develop it in college. Responsibilities should be placed largely upon the student during his college career.

Much discussion was brought about over the qualities the teacher should possess, but these can be summed up as follows: he should possess mental calibre, unusual facility in expressing himself, and tact in dealing with men. Extreme cleverness in an instructor, it was shown, was a handicap, for the student's difficulties are not the teacher's difficulties, and the resulting discussion will in all probability be carried over the heads and beyond the concept of those who are supposed to profit by it. The usual argument arose whether the teacher should devote part time to professional practise or to book-writing in conjunction with his college work, but as this is beyond the purpose of the report I shall but briefly call attention to the return of the time honored problem. It was further pointed out that coöperation among teachers will profoundly minister to the effectiveness of the instruction, and that a better degree of efficiency in teaching would be reached by the aid of faculty seminars or conferences, at which times the troubles of the instructors could be aired and the resulting discussion be of mutual benefit to all. Personally I believe that those who are newer to the teaching profession can learn wisdom from those of older experience if these latter are willing to give it.

So far I have but briefly treated in outline the many sub-

jects and thoughts along the line of improvement in our college work, and whilst criticisms of existing conditions were many, yet they were of value since discussion brought suggestions and remedies. The main thought showed the need of reorganization of existing courses and it was suggested that a decided effort should be made to standardize the engineering courses of the country, and that this standardization was to be of such nature that the fundamentals of a course given in civil engineering, for example, at Tufts College should not differ materially from one given in a western or a southern school.

To further expedite these improvements a special plea was made that the interest of the trustees of the college should be solicited in the appointment of an assistant to the president, whose duties should be particularly to investigate the teaching problem in all colleges, beginning by first making a thorough examination of his own school. The investigation should be of the nature of an efficiency problem both as relate to instructors and departments, and also as to the coördination of the work and the establishment of a general policy. In this efficiency study there should be an effort to eliminate as far as was deemed advisable such courses as were not found to be fundamental and of vital interest.

Second in interest to the general problem of engineering education was the question of college administration. An interesting comparison was made between the college and a business, at the time of the discussion of this paper. It was pointed out that the college while not a business organization yet needed a careful business administration and that it was of vital importance to the affairs of the college that all finances and properties should be administered efficiently. While the college is not a business enterprise, yet since it receives revenues in a manner not unlike a business project, this necessitates a thorough accounting system.

To secure maximum efficiency in the administration of the property of the college and also to make possible a greater degree of efficiency to the use of the buildings proper, it was recommended that special efforts should be made to secure the maxi-

mum use of all buildings and apparatus and that the arrangement of the courses should be made with this in view. One statement as made at the meeting is, I believe, applicable to all colleges and that is the tendency to purchase apparatus to secure some particular experiment, not with the view of securing the maximum effort and thus reduce the cost, but for some special case.

In this connection a special plea was made to secure in the college and amongst all departments a system of inter-departmental accounting. Each instructor should be charged with each particular piece of machinery or instrument as he would be in private work. Whether such safeguards are necessary at Tufts is beyond my knowledge but I present it together with other thoughts as they were indicated to me.

To secure efficient administration it was claimed that no teacher should be permitted to carry an overload, and a discussion resulted over the argument whether the teacher should be permitted to carry on private work in connection with his college duties. A plea was made to investigate the interrelation of courses, the length and frequency of the lecture hour, recitation and laboratory periods, the size of the classes, and the part of the day utilized. It was claimed that certain courses would be taught more efficiently and better at certain periods of the day than at other times. Such a study of conditions would naturally involve many questions other than those presented, but when psychology plays such an important part in business affairs, it is but reasonable to assume that it has its place in teaching.

One of the most interesting discussions was brought about when the idea was presented of further harmonizing the college interest with those of the business world. As an aid to the future employers a scheme of grading men was suggested. No one realizes better than your delegate the serious problem presented, when several years after a young man's graduation one is asked to recommend him. Our class books are usually our only record and this but indicates what the man has done in class work. His rank may be low from the

record at hand and unless the instructor has an excellent memory and can analyze character he is in a predicament how to reply. To accomplish this grading and to aid future reference in the college office it would seem in the line of progress to consider such a scheme of grading men for record. These records should come from the individual instructors in whose classes the men are, and records likewise may be secured from the student. A scheme similar to the one outlined by Professor Harding, of Purdue University, in the grading of students might form the basis of an investigation for the development of this idea. In this scheme the custom is to obtain a majority vote of all the instructors in a given school expressing personal opinion of the student aside from his scholarship. The personality characteristics were grouped into two divisions by Dr. Kent, who took part in the resulting discussion, wherein the characteristics that would be determined by the instructor would be habits, reliability, industry and self reliance, and that those of which the student body would most likely be the best judges were mental calibre, accuracy, address and popularity.

There were two meetings assigned at the convention for the institutional delegates, one at the opening of the convention and the other at its close. This is a new departure in the Society work and promises excellent results at future meetings. At the first meeting the delegates were informed that it would become a part of the duties of each delegate to report back to his faculty the facts patent to him during the meeting which he felt of importance.

The second meeting of the delegates was thrown open for informal discussion of the papers presented during the convention. As a result of these informal replies, brief as they were but numbering forty or more, I wish to present the findings at this meeting together with what I have designated as institutional recommendations. The first, and considered of great importance, was to call attention to the important articles appearing in the Society BULLETIN during the coming year. This I have already been informed by Dean Anthony has been

taken care of, and as you are already a member of the Society this recommendation will appear merely as a reminder.

The second recommendation was to call to the attention of the members of the faculty the work of the Society in the improvement of the papers in the BULLETIN, and the gradually raising of papers from those of minor importance to those of vital importance. It was further requested that the attention of the faculty should be brought to the fact that the BULLETIN welcomes papers from all members of the Society.

The third recommendation was to call attention to the importance and desirability of each college having a delegate to represent it at each annual meeting; that the delegate should be instructed as to his attitude and the impression he should create, and further that he was charged with a heavy responsibility; that the delegate, preferably, should be one of the younger men since he would be the one who would most likely profit the most. These constitute the recommendations at the last meeting of the institutional delegates.

In concluding this report, I wish to say that my observations at the meeting have been, and will be, more and more profitable to me as the time passes. By far one of the greatest benefits to me was the opportunity to meet men of national repute, the leaders of engineering thought, and the chance to have informal discussions with them; the exchange of thought with teachers of my own subject were indeed very profitable to me and in exchanging ideas the benefit will be lasting. It is my sincere hope that our engineering school may be represented at the next convention not only by a delegate but by a still greater number of the faculty than attended the Princeton meeting.

DISCUSSION: "ELECTRICAL ENGINEERING LABORATORY INSTRUCTION."*

BY O. J. FERGUSON,

Professor of Electrical Engineering University of Nebraska.

There is much in the paper by Professor Munro with which I can heartily agree. There is considerable which is very suggestive to me. And finally there is a part which seems to be counter to the results of my own experience.

I like the idea of the "study" of a d–c. motor, the "study" of an induction motor, etc. It implies correlation and a final entity for the group of exercises which go to make it. Again, emphasis made upon interpretation of experimental results is well placed.

To a limited extent, I will agree that the manual labor of assembling one's machines will give added value to the work. But, in the course of one year (or more) spent in laboratory practice, a great deal of time can be lost by requiring this labor of each group and in each experiment, with the additional requirement of tearing down and putting away all apparatus.

Before the average student has finished his first year in the laboratory, he has approached the saturation point of the curve plotted between energy expended on grouping the machines available and the beneficial results obtained therefrom.

As a further indication of my point of view, I might remark that the arrangement which Professor Munro describes is properly classified with curriculums which give a large amount of manual training, shop courses, etc. It probably adds to the general popularity of the course as a whole but I challenge the practice as being less effective in the long run.

In my opinion, there should be enough of laboratory prac-

* By Melville S. Munro, in the November Bulletin.

tice connected with the study of any theoretical course to serve as illustrations and as "filing labels" for the mental experiences; *i. e.*, for the theory. To go very far beyond this puts into the curriculum something which can be learned better elsewhere, at the expense of crowding out something which one can learn later only with difficulty, and under disadvantageous conditions.

It is true that anything put into the course which will require the student to take the initiative or to make a choice or form a judgment is of value. My main contention is that the plan outlined has very serious disadvantages as well as its advantages.

DISCUSSION: "ELECTRICAL ENGINEERING LABORATORY INSTRUCTION."

BY V. L. HOLLISTER,

Associate Professor of Electrical Engineering University of Nebraska.

Referring to the article "Electrical Engineering Laboratory Instruction," by Melville S. Munro, in the November BULLETIN of the S. P. E. E., I would like to make the following comments.

The course of laboratory work laid out by Professor Munro is a departure from the usual methods employed in schools where many students must be accommodated in that the student takes the responsibility and manual labor necessary in setting up the required apparatus. We who have charge of electrical laboratories and adhere to the "standardized tests" and set apparatus must answer for our conservatism, non-progressiveness, or lack of appreciation of the advantages in the system presented by Professor Munro, hence my remarks.

We must appreciate that a thorough discussion of principles, methods, and results to be obtained is a great help to the student especially when presented at a conference just preceding a laboratory period. The proof that the subject is understood would then be the satisfactory and successful accomplishment of the results sought in the laboratory would follow without any further directions. Even the apparatus should be dis-assembled as far as possible. The responsibility assumed by the student, the experience in setting up his machinery, and the self reliance gained by successful results obtained are the decided advantages of this system.

It will appear, however, that the average laboratory period is too short for this. To take a motor and generator and belt them up together, secure them to their ways, and set up a creditable assembly of apparatus would, with the average

student, require at least an amount of time equal to that now given to wiring and making tests. To place the full responsibility upon the student, that is, to effectively and truly carry out the objects of the proposed system, the laboratory should be accessible to a student only during the time that he is engaged in performing an experiment. His choice of apparatus and assembly should not be influenced by seeing some one else engaged in the same work. The above consideration, we believe, will make this system fail where large numbers of students are handled with limited apparatus; where the laboratory must be used by more than one group of students; and where it is impossible to remove all traces of previous work. Aside from the facts that the best and most modern-looking apparatus would always be preferred by the student, that the laboratory would appear like the shipping room of a manufacturer, and that those things which the student might do to accomplish his needs, which an instructor would not allow, would inevitably be done, there are still serious reasons why this system should hardly be adopted by large state universities where the grade and number of students are as at present.

It appears to some of us who have not tried this system that much of the preliminary work in the electrical laboratory would require an excess of time over that required by our present system; that the laboratory instructor would have to scrupulously guard against pointing out the apparatus to be used and against too strongly influencing the student's choice; and that the wear upon the laboratory and equipment with large classes would be abnormal. We feel that the system would depend for its success upon the attitude of the instructor to a greater extent than does the present method; that the freedom from set apparatus and inflexible assemblies might just lead to additional manual labor and "shop work," and that most students are not ready to exercise the proper care and take a serious view of the responsibility placed upon

them, at least, until their assignments can be considered advanced work.

A comparatively large stock of pulleys, universal couplings, and duplicate machines, together with a more or less complete standardization of machine mountings and belt speeds would be necessary in order to give complete freedom from limitations. These are points to be considered.

However, we feel that the practice advocated by Professor Munro is to be incorporated in advanced laboratory work in so far as it may be found practicable, and we are heartily in favor of developing the initiative and self reliance of the student as much as possible. As to the elimination of the rather complete written report on the laboratory work for undergraduate work, we feel that such a step is in the nature of conducting classes without examinations and without recitations. The training in expressing ideas and using theory to explain the phenomenon observed is invaluable. Such written reports are necessary for the instructor to judge of the development in the student's mind of a "feeling" for the subject.